THE SETTLEMENT OF TROPICAL AUSTRALIA.

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The fundamental problem in Australia is the settlement of her empty tropical area. Opinions as to its economic value are most conflicting. A recent report stated that it is "undoubtedly the best and richest portion of the continent"; while I have just heard of a returned settler who declared that the only aspect of the Territory which pleased him was that which he saw from the stern of a southbound steamer! The truth, as usual, lies between.

It is on the whole fair pastoral country—which is very lightly stocked at present. It has limited areas of rich, agricultural land— which are practically untouched. In the hinterlands it has numerous mining fields, usually of medium grade—many of which have been abandoned owing to lack of labor. No serious student can doubt that natural resources of very considerable value are awaiting exploitation—but the great handicap, whether it be actual or only imagined, is certainly to be found in the climate.

In the following brief article I shall dwell chiefly on this aspect of the problem, more especially as it concerns the undeveloped areas in the Territory and West Australia.

A very cursory acquaintance with hygienic and economic problems leads one to the conclusion that the two climatic features which are most usually discussed—i. e., average temperature and annual rainfall—are of relatively minor importance.

As regards the human organism the factor of humidity is of greater importance than temperature. As regards plant life the season and reliability of the rain are at least as important as the total amount.

We can, with comparative ease, map Australia to show the rain reliability fairly accurately.

Suppose we consider the annual rainfall at Melbourne for a long period of years, and find the deviation from the normal in each year. We observe, of course, that in some cases the total annual rainfall is above the average (25 inches) at other times below this figure. If we take these deviations and average them, we find an average deviation of 12 per cent from the normal. Thus we may ordinarily expect fluctuations from 22 inches to 28 inches a year at Melbourne.

If now we apply the same test to the eastern portion of the Barkly Tableland—a valuable grazing area in the Northern Territory—we find that the reliability is much less and the average deviation is nearly 50 per cent (see the shaded areas in the map). Hence here the rainfall may be anything between 12 inches and 37 inches—although on the average it is much the same as at Melbourne.

So far as I know those optimists who propose to grow wheat in our tropical lands have given little attention to the season of the rain; and none at all to its reliability as discussed above! As I have shown elsewhere there are some regions where economic wheat growing may be possible in our hot lands—but they are neither in the Barkly Tableland nor in the south of the Territory.

Now let us turn our attention to another factor which is a potent control in tropical lands. It is generally accepted by physiologists that the best available instrument for testing the suitability of a region as regards habitability, is the wet-bulb thermometer.

Prof. Gregory has adopted 78°F. (wet-bulb) as an upward limit—"above which continuous hard work becomes impracticable." I do not agree with him altogether, for 78°F. (wet-bulb) is quite common along our northern coast—but this statement (by a strong supporter of tropical white settlement) will free the following deductions from a charge of exaggeration.

For reasons which I have elaborated elsewhere, I have adopted 70°F. (wet-bulb) as the limit of comfort for our race. This means that when the average wet-bulb remains above 70°F. day after day for a long period conditions are not favorable for close white settlement. An open-air, active occupation, such as stock-riding, has little to fear; but strenuous field labor, sedentary indoor life, and especially domestic work and the care of young children cannot (in my opinion) be carried on under favorable circumstances at present, with continuous high wet-bulb temperatures of this order.

Here I shall be met with numerous descriptions as to how "John Jones lived to 95 and never left the tropics"; how "Mrs. Jones raised five healthy children"; how that excellent clerk Brown "pines to return to the healthy life in the north", and so on and so forth.

These statements are all true—but they do not represent average conditions, nor are these sturdy pioneers (to whom be all honor) typical emigrants. Close settlement, unfortunately, depends on an influx of average settlers. There is nowhere in the world, so far as I am able to discover, a region resembling our northern coast lands with an important white settlement.

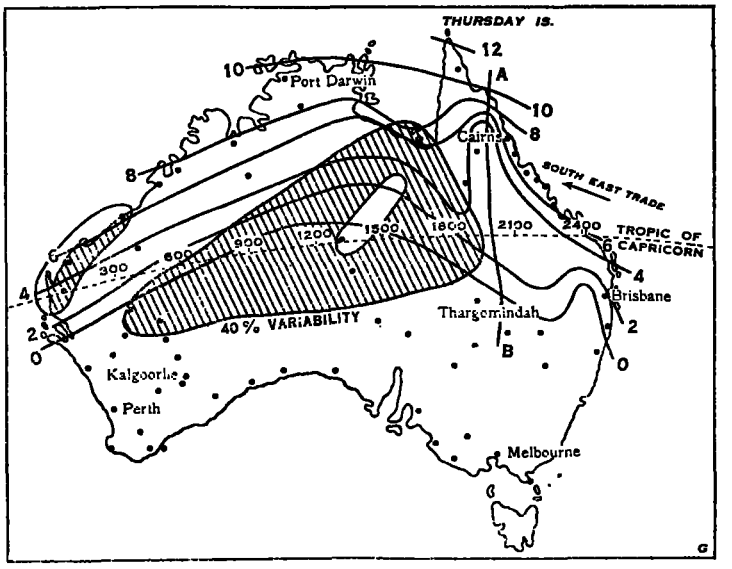

FIG. 1.—Important climatological boundaries for Australia. *A–B* separates the eastern fairly uniform rain region from the western winter-drought region. Shaded areas have very erratic rains (40 per cent variability). Lines connect points having the same number of months with an average wet-bulb temperature of 70° F., e. g., Thursday Island has 12 months, Brisbane has 2 months of that condition.
Approximate scale of miles is indicated on the Tropic of Capricorn.

In the map (fig. 1) I indicate approximately how this question of wet-bulb temperatures affects close settlement in our tropics. Many of my readers have anathematized those oppressive days in February which are so disagreeable a feature of Sydney (and indeed in much less degree are not unknown in Melbourne).

Yet Sydney has no month approaching an average of 70° (wet-bulb). Brisbane has two such disagreeable months, and conditions become continuously less attractive as we travel up the coast. At Mackay such high wet-bulb temperatures obtain for 6 months in the year, at Cooktown for 10, and at Thursday Island all the year round.

[1] Communicated by the author.

Probably one or two disagreeable months in the year have no particular effect on the well-being of the settler—but let us follow the 6-months isopleth on the map. It runs along the Queensland coast north of Mackay, sweeps to the north of the Atherton Tableland (that most promising region in our tropics!); along the Gulf coast, through Daly Waters, and along to Roeburne, W. A.

This line is no fanciful creation but is a definite climatological boundary. Yet I should point out that the unfavorable zone thus marked out is not all of one type. Another factor comes in which, luckily, greatly ameliorates conditions on the Queensland coast. Here blow the steadiest onshore winds in the world—the Southeast Trades. A high wet-bulb temperature, if accompanied by a fresh breeze, is robbed of half its terrors. Unfortunately the effect of local winds on health and comfort has not been investigated in our tropics, and my own experience is limited to the Queensland coast.

Having shown that the 6-months isopleth on the map has a real climatological value, what bearing has it on the settlement of our tropics? It will be noticed that it is precisely the low-lying river alluvials which are adversely affected. Here irrigation may ultimately be possible, for there are many truly fine rivers running into our northern seas. But I doubt if a white farming community will settle in these suitable areas for very many years, and this brings me to the last section of this article.

I have found it a comparatively simple matter (by means of diagrams which I have called climographs) to compare very closely the climatological conditions in our tropical towns with conditions obtaining in other parts of the world. Thus Darwin has the same climate as Cuttack, in India; Broome is like the mouth of the Congo; Townsville resembles Calcutta closely.[2]

Assuming that these and similar parallels are correct, we see that the analogous regions (homoclimes) for Darwin are settled by Siamese, Indians, and Bantu blacks, and in northern Brazil by half-caste Portuguese. Wyndham (the hottest of all moist climates recorded), has for homoclime only the extreme tip of India. Broome's homoclime is settled by Bantu.

Only in the inland country like that around Tennant's Creek, have we a homoclime even sparsely settled by north Europeans. This is the recently conquered German territory of Southwest Africa.

In eastern Brazil is a most interesting series of settlements; but the Germans have settled in the homoclime of Grafton; the Italians in Brazilian "Brisbane," and only the Spanish emigrants touch even the coolest tropical regions.

We learn, therefore, from our brief but comprehensive climatological study that Australia is ahead in tropical settlement as in other sociological experiments. Her white sugar growers around Cairns and Mourilyan are the advance guard of the white farmer in the Tropics.

I have no space to do more than mention one great asset in our northern lands—their remarkable freedom from such scourges as yellow fever, beri-beri and malaria. There seems good reason to hope that even the latter will soon be almost stamped out.

What then is indicated as regards the immediate future of our empty northern lands? I have no novel suggestions to make. The country is a pastoral one—it is not, in my opinion, an agricultural region. Quite apart from questions of labor and market I do not think that the north coast agricultural areas are suitable for white labor at present.

I have several times in this article hinted that conditions may be more favorable in the future. In four or five generations there is reason to believe that our native born will become thoroughly acclimatized in the subtropical areas, and will gradually expand into hotter and more humid zones to the north.

Until that time arrives let us develop the pastoral industries. Let us build railways, dig wells, and sink artesian bores. Let us strengthen our naval and aerial fleets. Let us, above all, have scientific direction and a definite aim. It is the lack of these which has ever hindered British enterprise, while they have made the Germans a world-shaking power. Fas est et ab hoste doceri.

[2] *See* Commonwealth Bureau of Meteorology Bulletin No. 14: Control of settlement by humidity and temperature . . . by *Griffith Taylor*. Melbourne, September, 1916. 32 p. 21 figs. 4°.—C. A., Jr.

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PRACTICAL HINT IN FORECASTING MINIMUM TEMPERATURES.

By WILLIAM G. REED, Meteorologist.[1]

[Dated: Pomona, Cal., Dec. 16, 1917.]

Referring to the use of the Smith-Donnel method of estimating the probable minimum temperature (this REVIEW, August, 1917, pp. 405 ffg.), I have tried the straight-line equation for the conditions at Pomona, Cal., and while the values of a and b were determined from insufficient data yet the method seems applicable to this locality. While a and b are most conveniently computed by Professor Smith's form of the equation (see 3, below) I suggest that in practical use the hygrometric formula be expressed as follows:

$$t_n = t_d + (a + br), \tag{1}$$

where t_n is the minimum temperature next morning, t_d is the evening dewpoint, r is the relative humidity, and a, b, are constants to be determined. Mathematically this expression is identical with

$$t_n - t_d = a + br, \tag{2}$$

which Prof. Smith has written (loc. cit., equation 1) as

$$Y = a + bR, \tag{3}$$

The advantages of the form of (1) are that the quantity sought is the only term on the left-hand side of the equation; the possible doubt as to the sign of Y, or $t_n - t_d$, is removed; and the equation represents directly what it actually is to the forecaster, viz, a means of modifying or correcting the current dewpoint so that it shall become the minimum temperature of the next morning. While there should be no doubt as to the sign of Y, in practice I have found that I have hesitated in writing the quantity, between $t_n - t_d$ and $t_d - t_n$. I believe that any change in the statement of the formula, which will make the mechanical operation automatic will be an advantage in practice.

The form of the statement by Prof. Smith is better for the study of the relationship and the theoretical development of the method; the form here suggested is intended only to minimize the chance of errors in the practical application of the relationship in actual forecasting.

[1] Conducting Weather Bureau investigations into protection against frost.